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Race and the Decision to Refer for Coronary Revascularization

The Effect of Physician Awareness of Patient Ethnicity

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OBJECTIVES We sought to assess whether there were differences, relative to racial ethnicity, in coronary revascularization recommendations made by a panel that had no knowledge of the patients' ethnicity.

BACKGROUND Coronary revascularization is employed less frequently in African American than in white patients. It is unclear whether this utilization pattern is driven by clinical differences between the two populations or by nonclinical factors.

METHODS Data were reviewed from 938 (26.5% African American, 73.5% white) consecutive cardiac catheterizations done between 1993 and 1995. Revascularization recommendations were made by cardiologists and cardiothoracic surgeons provided with the patients' clinical and angiographic data, but without knowledge of their ethnicity. Revascularization recommendations were compared between African American and white patients and correlated with clinical characteristics.

RESULTS No difference was noted in the percentage of African American and white patients recommended for revascularization, without reference to whether the recommendation was for percutaneous transluminal coronary angioplasty (PTCA) or for coronary artery bypass graft surgery (CABG) 40 vs. 46%, p = NS). African Americans were recommended more frequently for PTCA (22 vs. 18%, p = NS), whereas CABG was recommended for more white patients (28 vs. 18%, p = 0.002). Significantly fewer African Americans had disease in the left main or left anterior descending coronary artery or in multiple arteries. After adjusting for age, co-morbidity, left ventricular dysfunction and the extent of coronary disease, African Americans were more likely to have a recommendation for PTCA (odds ratio [OR] 1.42, 95% confidence interval [CI] 0.96 to 2.11, p = 0.08) and less likely to have a recommendation for CABG (OR 0.59, 95% CI 0.37 to 0.94, p = 0.02).

CONCLUSIONS This study suggests that when only clinical factors are considered, the rates of recommendations for revascularization will be similar for white and African American patients; but the type of revascularization procedure may differ by ethnicity and may depend, in part, on clinical factors. (J Am Coll Cardiol 2001;38:698–704) © 2001 by the American College of Cardiology

Although coronary artery disease (CAD) is the leading cause of death among both African Americans and white Americans (1–4), several studies have reported a racial discrepancy in the use of revascularization procedures (i.e., coronary artery bypass graft surgery [CABG] and percutaneous transluminal coronary angioplasty [PTCA]) as treatments for this disorder (5–14). These observations have been reported in clinical trials of revascularization (7,8,15,16), in surveys of data bases consisting of Medicare cohorts (17), Veterans Affairs Medical Center cohorts (9,10) and single-center cohorts (18) and in state-based registries (19). Although some studies show that African Americans with CAD do as well as whites (10,15), despite the difference in procedure utilization, other studies report a worse prognosis in African Americans with cardiovascular disease (8,12,18). Recent U.S. surveys continue to indicate a 40% to 85% higher rate of heart disease mortality in African Americans compared with whites (2–4,18,20,21). Thus, the lower utilization of revascularization procedures may contribute to the poorer outcome reported in African Americans with CAD (1,3,4,18).

Patient ethnicity as an independent and important determinant of treatment decisions for CAD has been difficult to evaluate. Attempts to statistically isolate the biologic and nonbiologic factors associated with ethnicity, which might guide physician treatment choices, have met with limited success. Separation of medical factors that determine procedure utilization, such as natural history, the distribution of CAD and the incidence of comorbidities, from nonmedical factors, such as the patients' socioeconomic status, the level of expertise of the physician caring for the patient, access of particular groups of patients to subspecialists, differences in the patients' acceptance of provider recommendations and differences in the physicians' perception of the patients' need for procedures, is problematic (22). Currently, data measur-

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Abbreviations and Acronyms

CABG = coronary artery bypass graft surgery
CAD = coronary artery disease
CI = confidence interval
LAD = left anterior descending coronary artery
LMCA = left main coronary artery
LV = left ventricle or ventricular
OR = odds ratio
PTCA = percutaneous transluminal coronary angioplasty

ing the relative importance of each of these factors in determining the racial variance in the utilization of revascularization procedures are lacking.

Analysis of data on health care services utilization from Medicare cohorts (15) represents one attempt to evaluate the role of racial variations in the utilization of revascularization procedures. There are considerable differences, however, in economic resources among Medicare recipients, so that a single health care payer does not guarantee equal access to procedures. Procedure utilization has also been examined in cohorts from Veterans Affairs hospitals, populations wherein economic differences among patients are diminished, and the presence of salaried physicians eliminates financial advantages to physicians who recommend or withhold specialized procedures. It is noteworthy that several surveys in Veterans Affairs hospital populations have reported differences in procedure utilization, according to race, that parallel those in the general population (9–11). Although registry-based reports suggest that race may importantly influence a patient's likelihood of undergoing revascularization procedures, these surveys were not able to evaluate the contribution that ethnic differences in coronary disease distribution, co-morbidity and nonmedical factors make to physician decision-making.

To assess whether ethnicity may be an independent, important factor contributing to differences in procedure utilization, it is essential to critically examine the individual steps leading to procedure utilization in selected populations in which the decision-making process can be closely correlated with clinical factors and in which socioeconomic differences among patients are smaller. At the Cleveland Veterans Affairs Medical Center, it has been the practice to review all coronary angiograms weekly by a committee composed of experienced clinical cardiologists, interventional cardiologists and cardiothoracic surgeons. Although the clinical symptoms and presentation are coupled with angiographic and physiologic data to arrive at a treatment recommendation, the patient's ethnicity is generally not presented. Thus, we had the opportunity to evaluate ethnic variability in provider treatment recommendations in a setting where the effects of socioeconomic status and physician financial incentives were minimal and physician knowledge of the patients' ethnicity was extremely limited.

To evaluate differences, by race, in procedure utilization at a key point in treatment selection (procedure recommendation after angiography), we reviewed 1,022 consecutive cardiac catheterizations performed between 1993 and 1995 for treatment recommendations made by this protocol, and we compared the revascularization recommendations in African American and white patients. Furthermore, to understand the possible role of anatomic and physiologic factors in the decision-making process, we compared the extent and severity of coronary stenoses, left ventricular (LV) function and comorbidity between the two groups.

METHODS

Study design and patients. The sample was drawn from 1,022 consecutive cardiac catheterizations from 1993 to 1995. Eighty-four patients undergoing repeat catheterization during the study period were excluded from consideration, because the procedure was done to evaluate valvular heart disease, myocardial or pericardial disease. Patients undergoing repeat catheterization (n = 56) in this interval were included if the catheterization resulted in a new treatment decision. A final cohort of 938 catheterizations in 882 patients forms the data base. Clinical data collected included that accessible from the Decentralized Hospital Computer Program data base, as well as data from detailed angiographic reports. Coronary anatomy (location, number and extent of coronary stenoses), LV function, as assessed by either angiography, gated radionuclide ventriculography or echocardiography, and comorbidity were noted for each patient. Data requiring a patient interview or chart review, such as severity of angina or symptoms of congestive heart failure, were not available for this retrospective study. Additional details of coronary anatomy requiring angiographic review, such as diffuseness of the disease and adequacy of target vessels, were also not collected.

Classification of CAD was based on visual interpretation using standard criteria (23,24). Grading of the severity of CAD was in accordance with the American Heart Association's Ad Hoc Committee for Grading of Coronary Artery Disease (25). The degree of stenosis was quantitated from the moving cineangiogram by visual estimation of the percent reduction in diameter relative to the caliber of the apparently nondiseased adjacent segments, with the range of lumen diameter reductions from 0% (normal coronary segment) to 100% (completely occluded vessel). When left main coronary artery (LMCA) disease was noted, measurements were made with handheld calipers and a magnifying scale. A lumen diameter reduction of ≥50% at the LMCA (equal to a 75% reduction in cross-sectional area) was considered significant. In CAD other than that in the LMCA, stenoses >70% were significant and considered proximal if they were located in the right coronary artery before the acute marginal branch, in the left anterior descending coronary artery (LAD) before the first septal perforator branch or in the left circumflex artery before the obtuse marginal branch. Significant lesions in the major

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branches of the left coronary artery system (i.e., anterior descending, diagonal, circumflex and obtuse marginal arteries) were measured and recorded.

Left ventricular function was measured by LV angiography in the majority of cases (n = 682). Calculation of ejection fraction by LV angiography was done using single-plane cine left ventriculography in the right anterior oblique projection using the area-length method. Cine angiographic data were processed by Trinity Computing systems (Greenway Plaza, Houston, Texas) and LV ejection fraction ≥50% was interpreted as normal, 35% to 50% as mild LV systolic dysfunction, 20% to 35% as moderate LV systolic dysfunction and <20% as severe LV systolic dysfunction. In 123 patients in whom a ventriculogram was not obtained, functional evaluation of the LV was determined from two-dimensional echocardiography or radionuclide ventriculography. The same quantitative criteria were used to describe LV function on a gated blood-pool study. Echocardiography of LV function was assessed semiquantitatively by experienced echocardiographers and was described as normal or mild, moderate or severe LV dysfunction. Estimation of ejection fraction by this echocardiographic method has been shown to be accurate and reliable when assessed by experienced echocardiographers (26,27).

Comorbidity was defined in the following manner: 1) the presence of clinically significant renal disease was defined by serum creatinine ≥2.0 mg/dl; 2) significant pulmonary disease was identified by pulmonary function tests (when available) and/or by the presence of bronchodilators or methylxanthines on the patient's computerized medication profile; and 3) diabetes was identified by the presence of either insulin or oral hypoglycemic agents on the patient's medication profile. Although hypertension is clearly more prevalent in African American than white patients, this variable (in contrast to the other co-morbidities measured) was *not* specifically noted, because its presence or absence neither contributes to a decision to revascularize nor influences the choice of the procedure.

All angiographic cases were discussed weekly in a cardiac catheterization conference by a committee consisting of an interventional cardiologist, a cardiothoracic surgeon and a clinical cardiologist. The committee reviewed all angiographic studies from the previous week, including those patients for whom urgent or emergent treatment had been required. Data presented for each patient were strictly limited to clinical factors that might influence the treatment choice. For this reason, the patients' ethnicity was not presented. The recommendation of this committee was considered as the final treatment recommendation.

Decisions regarding the mode of therapy were based on clinical and angiographic variables. Angiographic variables included the number and location of diseased vessels, the presence or absence of LMCA disease, the extent of disease in the distal vessel, LV systolic function and regional contractile function of the territory supplied by the diseased vessel. The clinical variables considered included the presence or absence of unstable angina, the severity of angina in patients with stable angina treated with medication, objective evidence of ischemia on radionuclide stress perfusion imaging or stress echocardiography and the presence of diabetes mellitus, renal or pulmonary disease. Patients with significant atherosclerotic disease in the LMCA and in all three major coronary arteries were referred for CABG. Most patients with double-vessel disease involving the proximal LAD and proximal right coronary arteries were also referred for CABG. Patients with single-vessel disease technically amenable to a coronary intervention and with objective evidence of ischemia were generally referred for a catheter-based intervention. Although patients with two-vessel disease not involving the LAD were often referred for PTCA, many also were referred for either medical management or CABG depending on the particular anatomic and physiologic findings. These treatment recommendations are consistent with those described for the Coronary Artery Surgery Study (22,23).

Table 1. Clinical Characteristics of Patients Undergoing Angiography

	African Americans (n = 249) (26.5%)	Whites (n = 689) (73.5%)	p Value
Age (yrs)	62.0 ± 10.0	62.4 ± 9.6	NS
Men	98%	97%	NS
Diabetes	35%	34%	NS
COPD	27%	27%	NS
Renal disease	11%	7%	0.04
LV dysfunction*	47%	34%	0.01
Previous CABG	11%	21%	< 0.001

*Data are based on 215 African American and 590 white patients in whom left ventricular function was assessed by angiography, radionuclide ventriculography or echocardiography. Data are presented as the mean value ± SD or percentage of patients.

CABG = coronary artery bypass graft surgery; COPD = chronic obstructive pulmonary disease; LV = left ventricular; NS = not significant.

Statistical analysis. Statistical analysis involved three steps. First, the demographic and clinical characteristics of white and African American patients undergoing left heart catheterization were compared by using the chi-square test or the Wilcoxon signed-rank test. Second, treatment recommendations in white and African American patients with significant stenosis in one or more coronary arteries were compared by using the chi-square test. Analyses compared recommendations for CABG, PTCA and revascularization by either CABG or PTCA. Third, to adjust for the potential confounding influence of demographic and clinical factors in recommendations, additional logistic regression analyses were performed. Separate analyses were performed for CABG and PTCA. Independent variables in these analyses included age, African American ethnicity, the presence of specific comorbid disease (diabetes, pulmonary or renal disease), LV dysfunction (classified as mild, moderate or severe), the number of coronary arteries with significant stenosis and involvement of specific arteries. The multivariate odds ratio (OR) associated with African Amer-

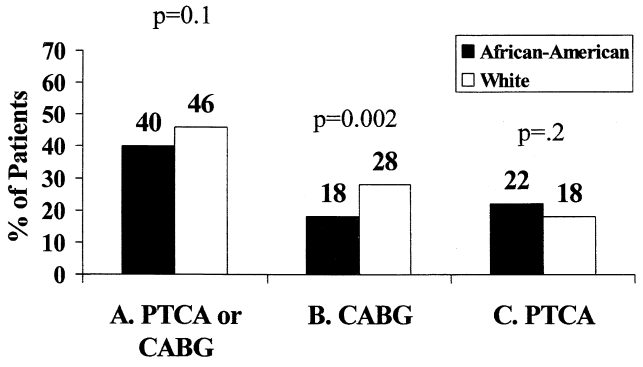

Figure 1. (A) The percentage of African American and white patients recommended for revascularization by either PTCA or CABG. **(B)** Percentage of patients referred for CABG. **(C)** Percentage of patients referred for PTCA.

ican ethnicity was used to estimate the relative rates of CABG and PTCA in African American and white patients.

RESULTS

The clinical characteristics of the study cohort are presented in Table 1. African American patients made up 27% of the study group and constitute ~30% of the population of the Cleveland Veterans Affairs Medical Center. The patients' mean age did not differ between the two groups, even when subdivided into three categories (age <65 years: 55 vs. 51%; 65 to 75 years: 39 vs. 43%; and >75 years: 7 vs. 5.8% for African Americans vs. whites, respectively). The percentages of male patients, those with diabetes mellitus or with chronic obstructive pulmonary disease were not different between the two groups. There were several noteworthy clinical differences. A somewhat higher proportion of African Americans had renal disease (11 vs. 7%, $p = 0.04$). More African Americans than whites had LV dysfunction (47 vs. 34%, $p < 0.01$), whereas more whites than African Americans had undergone previous CABG (21 vs. 11%, $p < 0.001$). Recommendations for revascularization procedures in African American and white patients are shown in Figure 1. The percentages of patients with coronary stenoses recommended for *any* revascularization procedure (either PTCA or CABG) were similar between African American and white patients (40 vs. 46%, $p = 0.1$) (Fig. 1A). By univariate analysis, more white than African American patients were recommended for CABG (28 vs. 18%, $p = 0.002$) (Fig. 1B), whereas more African American than white patients were recommended for PTCA (22 vs. 18%, $p = 0.2$) (Fig. 1C). Additional stratified analysis examined treatment recommendations in patients with significant stenosis of one, two or three or more coronary arteries (Table 2). Importantly, no significant differences in treatment recommendation patterns, in terms of race, were observed when patients were stratified by race and number of significantly stenosed coronary arteries.

When the numbers of coronary arteries with significant stenoses were compared in terms of race, African Americans were more likely than white patients to have zero, one or two coronary arteries with significant stenosis, whereas more white patients had three or more stenosed arteries (Fig. 2A). No significant coronary disease was observed in 72 African Americans (28%) and in 149 white patients (21%; $p = 0.02$). A comparison of the distribution of coronary stenoses in the two racial groups also revealed important differences (Fig. 2B). Fewer African American patients had LMCA stenosis (6 vs. 11%, $p < 0.01$), LAD stenosis (44 vs. 59%, $p < 0.001$) and right coronary artery stenosis (50 vs. 58%; $p = 0.01$). The percentage of patients with left circumflex, obtuse marginal or diagonal coronary artery stenoses did not differ between the two groups.

Finally, using logistic regression analysis, African American and white patients with stenosis of one or more arteries were compared for differences in recommendations for CABG and PTCA after controlling for the influence of age, co-morbidity, location and number of diseased coronary arteries, LV function and previous CABG. African Americans still tended to be more likely to receive PTCA (OR 1.42, 95% confidence interval [CI] 0.96 to 2.11, $p = 0.08$) and significantly less likely to receive CABG (OR 0.59, 95% CI 0.37 to 0.94, $p = 0.02$). A slightly but not significantly higher percentage of African American (46%) than white (39%) patients underwent the recommended procedure at the Cleveland Veterans Affairs Medical Center within 90 days of catheterization.

DISCUSSION

Recent reports demonstrate a substantially lower utilization rate of coronary revascularization procedures in African American than in white patients, with limited data to elucidate the reasons for this difference. Our study focused on one of the key steps in treatment selection—namely, the treatment recommendation after angiography—and related revascularization procedure recommendations to selected angiographic and clinical findings. Data presented in this

Table 2. Rates of Revascularization Procedures by Numbers of Stenosed Vessels and Ethnicity

	One Artery			Two Arteries			Three Arteries		
Procedure	African Americans (n = 47)	Whites (n = 110)	p Value	African Americans (n = 51)	Whites (n = 121)	p Value	African Americans (n = 79)	Whites (n = 309)	p Value
PTCA	32%	24%	0.3	43%	31%	0.1	22%	20%	0.7
CABG	4%	9%	0.3	14%	25%	0.1	44%	48%	0.6
Either	36%	32%	0.6	53%	55%	0.8	66%	67%	0.9

Data are presented as the percentage of patients.
CABG = coronary artery bypass graft surgery; PTCA = percutaneous transluminal coronary angioplasty.

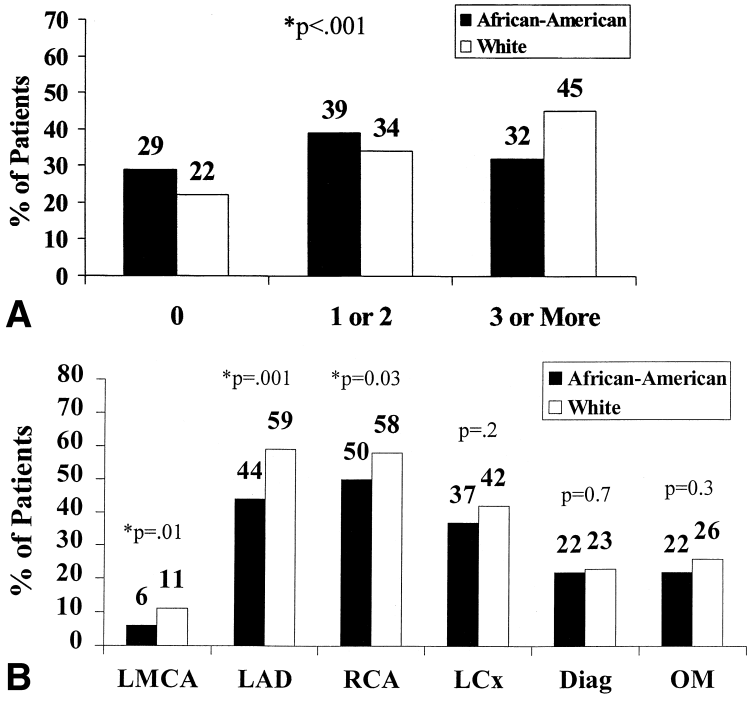

Figure 2. (A) The percentage of African American and white patients with significant stenosis in zero, one, two or three or more coronary arteries. **(B)** The distribution of coronary artery stenoses in African American and white patients. LAD = left anterior descending coronary artery; Diag = diagonal coronary artery; LCx = left circumflex coronary artery; OM = obtuse marginal artery; RCA = right coronary artery.

study suggest that when recommendations for revascularization procedures are driven by clinical factors, the racial difference in the rates of revascularization become greatly diminished. In addition, the study suggests that there may be clinical explanations for the racial differences in the choice of the revascularization procedure.

The recommendation for CABG or PTCA after cardiac catheterization was compared in African American and white patients, by using a protocol in which revascularization recommendations were made on the basis of angiographic findings by a panel generally unaware of patient race. Although absolute blinding of the panel to patient race could not be assured, patient ethnicity was rarely presented due to the structure of the conference. Importantly, in contrast to previous reports in the published data, when referral for a revascularization procedure was made by the protocol described, there was no difference between the two groups in the percentage of patients referred for revascularization by any procedure. By univariate analysis, CABG was significantly more likely to be recommended for white patients, and PTCA was marginally more likely to be recommended for African American patients in our sample. Multivariate regression analysis adjusting for age, comorbidity, location and number of coronary stenoses, LV function and previous CABG revealed that white patients were still more likely to undergo CABG and African American patients were slightly but not significantly more likely to undergo PTCA. However, when the two groups were stratified simply by the number of vessels and procedure (Table 2), no difference in procedure utilization by the number of involved vessels was identified. Differences in coronary anatomic features and LV function between the two ethnic groups (e.g., significantly lower incidence of LMCA, LAD and three-vessel CAD in African American patients) could account for the differences in the choice of PTCA versus CABG that remained in our cohort. In addition, factors such as target-vessel morphology (i.e., diffuse vs. focal disease), the presence and severity of angina and heart failure symptoms, which were not included in the regression analysis, may be important.

Ethnic patterns of coronary revascularization. Although the recommendation for treatment is different from utilization, it is a key step in treatment utilization. Only one previous report specifically addressed racial differences in physicians' recommendation for CABG, and thus could be compared with our study (28). Maynard et al. reported that 46.5% of African American patients, compared with 59.4% of white patients, were recommended for CABG. This highly significant difference paralleled the observed difference in procedure utilization in their cohort. Importantly, the investigators specifically noted that the clinical and angiographic characteristics of the two groups were not sufficiently different to account for the difference in treatment recommendation (28), but no details of the recommendation process were provided.

A review of Medicare and Veterans Affairs data bases (5,9,17) has found significantly greater utilization of CABG and PTCA in white than in African American patients. When Medicare patients were stratified by race and income to adjust for differences in socioeconomic status (5), the

racial difference in procedure utilization persisted across all income ranges. When cardiac catheterization and revascularization rates were compared in African American and white veterans after an acute myocardial infarction (10), African Americans were significantly less likely to undergo cardiac catheterization, PTCA or CABG. Although these registry studies provide important information on the rates of procedure utilization, factors guiding utilization were not examined.

Two studies in which patients were stratified by race and disease severity (6,18) reported that African Americans were less likely to undergo CABG at all levels of disease severity, including LMCA disease (6). Of note, the outcome of African American patients was significantly poorer (18). In these and other cohorts (7,15), investigators noted a lesser prevalence of LMCA and three-vessel coronary disease in African Americans.

The contrast between these previously reported patterns of revascularization referral and procedure utilization and the results of our study suggests that race may be an important independent factor for physicians making treatment decisions.

Factors contributing to procedure use. We recognize that the etiology of the racial difference in procedure utilization is both multifactorial and complex. Patient-based biologic factors may contribute to ethnic variation in utilization patterns. Data from several studies have suggested that differences exist in the anatomic distribution or severity of CAD between African Americans and whites (3,7,12,15,16). Although many studies have involved large numbers of patients (7,15,16), the percentage of African Americans included in these studies was quite small, leaving open the possibility that the African American patients in these cohorts consisted of selected subgroups not representative of the African American population as a whole. Importantly, not one study supported the concept that lesser procedure utilization in African Americans could be exclusively attributed to lesser disease burden.

Patient socioeconomic status and culturally based determinants of physician decision-making, such as the level of expertise of the physician caring for the patient (specialist vs. generalist), access of particular groups of patients to different levels of physician expertise, the physician's perception of the patient, as well as cultural differences that interfere with the patient's acceptance of physician recommendations (23,28), may also have an impact on treatment recommendations. The role played by each of these factors requires separate study.

Study limitations. Although the results of this retrospective review are highly provocative, there are some study limitations requiring further evaluation of this model. It must be emphasized that our study does not examine how patients are referred for cardiac catheterization—another crucial step in the decision process leading to revascularization. We were able to examine the revascularization decision process only after catheterization. However, other studies scrutinizing patient management after catheterization have found different patterns of procedure utilization (6,9). Other variables, such as the appearance of target vessels, collateralization, the presence of diffuse as opposed to focal lesions, the severity of angina and symptoms of congestive heart failure, which might influence treatment decisions, could not be readily examined in this review. Another study limitation was the inability to assess patients' reception of the treatment recommendation. Although a similar proportion of African American and white patients (46 vs. 39%, p = NS) underwent the recommended procedure at this Veterans Affairs Medical Center, we have no information on the patients who did not. Finally, this study was not a prospective study with strict physician blinding to patient race; rather, it was a retrospective study taking advantage of a decision process in which patient ethnicity was generally unknown to those making the decision regarding procedure referral. Nonetheless, our findings that the overall revascularization rate did not differ between racial groups and that differences in treatment did not exist when patients with one-, two- or three-vessel disease were compared, in contrast to other reports in the published data, suggests a critical need for additional research on the clinical and psychosocial factors directing physician utilization of specific cardiovascular procedures.

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